REMARKS

Claims 54, 92 and 95 are amended. Claims 5, 19, 32, 33, 40, 45-49, 51, 83, and 96 were previously cancelled, without prejudice to the underlying subject matter. Please consider the following remarks.

Claims 50, 52-69, 92-95, and 97 stand rejected under 35 U.S.C. § 112, first paragraph, as failing to comply with the written description requirement.

Claim 50 defines a method of forming an integrated circuit and recites, in part, "said first and second plasma treatments being configured to prevent the formation of silicon oxide on a bottom of said contact opening." It is understood from the Office Action that this is the objectionable portion of the claim. This element of claim 50 does not requiring *no formation* of silicon dioxide during plasma treatment. It requirs the dual plasma treatments to be configured to prevent the formation of silicon oxide on a bottom of said contact opening." There is a difference. The ultimately formed integrated circuit is desired not to have non-conductive silicon oxide at the bottom of a contact opening, which would interfere with the performance of electrical devices utilizing any contact formed in that opening. This is the reason for having two plasmas instead of just one oxygen based plasma. As stated at page 13 of the specification:

> a conventional O_2 plasma dry etch may first be utilized to remove a large portion of the polymer etch residue up to a point where some etch residue still remains a the bottom of the opening . . . Following this conventional O_2 plasma etch, the ammonia dry etch, as heretofore described, is then used to complete removal of the polymer etch residue, including

> at the bottom of the opening, without producing a silicon rich oxide. In addition, it is also possible to utilize hydrogen gas or methane in lieu of NH_3 during the polymer removal step.

As this excerpt from the specification explains, the dual plasma treatment does not form silicon rich oxides, such as silicon oxide, at the bottom of the contact opening where optimal electrical contact is important for later formed circuitry. As expressed in the background of the specification, silicon rich oxides like silicon oxide are substantially non-conductive and interfere with the deposition of conductive materials in the opening and negatively effects the performance of the contact. This us undesirable and is remedied by the two plasma technique recited by the claim where the two plasmas are configured not to form unwanted non-conductive material at the bottom of the contact opening. The claimed subject matter is clearly set forth in the specification so as to indicate the Applicants' intellectual possession of it as of the filing of the Application. Therefore, the specification is satisfactory under 35 U.S.C. § 112, first pargraph, and the rejection of independent claim 50 and dependent claims 53 and 53 is respectfully requested to be withdrawn.

Claim 54, as amended, defines a method for removing polymer etch residue from an etched opening in a silicon wafer device and recites, in part, "wherein said first and second plasmas are configured so as not to leave silicon oxide in said opening after said subsequent contacting." Again, as with claim 50, the specification clearly explains that this plasma treatment configuration prevents the leaving silicon rich oxides, such as silicon oxide, that would interfere with the resulting device, in the opening. As was the case with claim 50, independent claim 54 and dependent claims 69 are fully supported under 35 U.S.C. § 112, first paragraph, by the specification and the rejection there under of these claims is respectfully requested to be withdrawn.

Claim 92, as amended, defines a method of forming an integrated circuit structure and recites, in part, "said first and second plasmas being configured to not leave silicon oxide in said opening after said first and second contacting, wherein said second contacting provides an oxide free bottom of said contact opening and does not oxidize sidewalls or said bottom of said opening." As with independent claims 50 and 54 discussed above, the method defined by claim 92 is fully supported under 35 U.S.C. § 112, first paragraph. The dual plasma methodology is disclosed in the specification as useful for removing polymer etch residue completely from an opening, but not leaving silicon oxide in the opening. Applicants respectfully request that the 35 U.S.C. § 112, first paragraph rejection of independent claim 92 and dependent claims 93 and 94 be withdrawn.

Claim 95, as amended, defines a method of forming an integrated circuit structure and recites, in part, "said removing preventing the formation of silicon rich oxide at the bottom of said contact opening." This claim is supported by the specification in the same manner as has been discussed above in relation to independent claims 50, 54, and 92. The rejection of independent claim 95 and dependent claim 97 under 35 U.S.C. § 112, first paragraph, is respectfully requested to be withdrawn.

Claim 54 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent 6,204,192 ("Zhao et al.") in view of U.S. Patent 5,970,376 ("Chen"). Applicants respectfully traverse this rejection.

Claim 54, as amended, defines a method for removing polymer etch residue from an etched opening in a silicon wafer device and recites "forming an opening in an

insulating layer, wherein a polymer etch residue remains within said opening after the opening forming step" and "first contacting said opening with a first plasma to remove a portion of said polymer etch residue" and "stopping said first contacting" and "subsequently contacting said opening with a second plasma to remove the remainder of said polymer etch residue, said first plasma being generated from a gas other than a hydrogen-containing gas and said second plasma being generated from a gas consisting of hydrogen gas, wherein said first and said subsequent contacting with said first and second plasmas are configured so as not to leave silicon oxide in said opening after said subsequent contacting." This is not taught or suggested by Zhao et al. in view of Chen et al.

The Office Action indicates that the Examiner has fully considered the Applicants' previous arguments that Zhao et al. in view of Chen et al. fails to teach or suggest "first contacting said opening with a first plasma to remove a portion of said polymer etch residue" and "stopping said first contacting" and "subsequently contacting said opening with a second plasma to remove the remainder of said polymer etch residue," and, in fact, indicates at page 6 that the references do not expressly disclose use of two plasmas in a residue cleaning method. However, the Office Action insists that the Zhao et al. reference does indeed disclose a two plasma residue cleaning method because it discloses a process of removing photoresist by ashing (conventionally done with oxygen plasma). This is incorrect.

The Office Action fails to take into consideration the four basic considerations which apply to obviousness rejections, namely: (A) The claimed invention must be considered as a whole; (B) The references must be considered as a whole and must suggest the desirability and thus the obviousness of making the combination; (C) The references must be viewed without the benefit of impermissible hindsight vision

afforded by the claimed invention; and (D) Reasonable expectation of success is the standard with which obviousness is determined. M.P.E.P. § 2141.01.

Considering the claims as a whole means that the steps must be looked at as a single process for removing etch residue. Neither Zhao et al. nor Chen et al. teaches or suggest any two plasma process for this purpose. Many different plasma techniques exist in the prior art, but none specifically use two separate plasmas in a single residue removal process, as recited by the claim.

Considering the references as a whole means taking into consideration portions of a reference that would lead away from the claimed invention. M.P.E.P. § 2141.02, citing W.L. Gore & Associates, Inc. v. Garlock, Inc., 721 F.2d 1540, 220 U.S.P.Q. 303 (Fed. Cir. 1983), cert. denied, 469 U.S. 851 (1984). When Zhao et al. is considered *as a whole*, as the M.P.E.P. and relevant case law requires, it is clear that use of a first plasma (stopped or not) in conjunction with a second plasma to remove residue is not taught or suggested.

Zhao et al. teaches away from using a two plasma process to remove residue, i.e., it instructs that use of the ashing technique relied upon in the Office Action as a first plasma treatment is not favored and dedicates the remainder of the specification to disclosing a technique to avoid using the ashing process. Zhao et al. informs a reader that when "an insulation layer is exposed to oxidizing or 'ashing' systems, which are used to remove a photoresist mask . . . , it has been found that the ashing process results in damage" (col. 1, ll. 55-59). Zhao et al. goes on to state in the same portion of the reference that this damage results in "dangling bonds which are very reactive and become water absorption sites if and when the damaged surface is exposed to moisture" (col. 2, ll. 3-5). It is clear that Zhao et al. is not urging the use of this ashing

technique with the residue removal plasma, and is in fact suggesting that it not be used, since nowhere in the description of the intended invention does Zhao et al. ever suggest that ashing is useful or desirable with its residue removal plasma (col. 3, line. 53 to col. 7, line 42).

Chen et al. provides no disclosure directed to combining the disfavored Zhao et al. ashing technique with the Zhao et al. plasma step for removing residue. Chen et al. does not contribute to the Zhao et al. disclosure if combined therewith so that a first plasma step removing some but not all of etch residue is combined with the Zhao et al. plasma step for removing residue. Without using impermissible hindsight using the present application as a roadmap, there is no reason to combine the disparate plasma techniques of Zhao et al. or to combine the methods of Zhao et al. with those of Chen et al.

Since Zhao et al. in view of Chen et al. does not disclose a method as recited by independent claim 54, this claim and all claims depending therefrom are patentable over Zhao et al. and Chen et al. Applicants respectfully request that the 35 U.S.C. § 103(a) rejection of claim 54 be withdrawn.

Claims 1-4, 6-18, 20-31, 34-39, 41-44, and 54-91 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Zhao et al. in view of U.S. Patent 6,277,733 ("Smith"). Applicants respectfully traverse this rejection.

Claim 1 defines a method for removing polymer etch residue from an etched opening in a silicon wafer device and recites, in part, "contacting said opening with a first plasma to remove a portion of said polymer etch residue; stopping said contacting

with said first plasma; contacting said opening with a second plasma to remove the polymer etch residue not removed by said first plasma, said second plasma generated from a gas consisting of ammonia and said first plasma being generated from a different gas, said second plasma forming a nitride deposit; and removing any nitride deposits formed by said second plasma in said opening." This method is not taught or suggested by Zhao et al. in view of Smith.

Neither Zhao et al. nor Smith, individually or in combination, teaches or suggest a two-plasma process of removing etch residue, such as the method of claim 1, i.e., "contacting said opening with a first plasma to remove a portion of said polymer etch residue; stopping said contacting with said first plasma; contacting said opening with a second plasma to remove the polymer etch residue not removed by said first plasma." As discussed at length above in relation to the patentability of claim 54 over Zhao et al. combined with Chen et al., Zhao et al. does not teach a two-plasma process for removing etch residue. It teaches away from using two plasmas and never indicates that two plasmas are useful for removing etch residue or should be combined in a single process. Zhao et al. instructs that the ashing process central to the Office Action's argument here is not to be used or else cause damage to the device being formed. This does not teach or suggest using two plasmas at all. Smith, likewise, discloses a process using a (meaning one) plasma to remove residue (col. 4, ll. 28-48). Therefore, since each reference merely teaches using a single plasma to remove etch residue, neither teaches or suggest a method of using two plasmas to do this job. Nothing in the references indicates that more than one plasma treatment is necessary or desirable to remove etch residue, so they would not be combined to create a phantom process using more than one plasma, as claimed. For these reasons, independent claim 1 is patentable over Zhao et al. and Smith.

Since independent claim 1 is patentable over Zhao et al. and Smith, so are dependent claims 2-4 and 6-15. Applicants respectfully request that the 35 U.S.C. § 103(a) rejection of independent claim 1 and dependent claims 2-4 and 6-15 be withdrawn.

Claim 16 defines a method for removing polymer etch residue from an etched opening in a silicon wafer device and recites "contacting said opening with a plasma consisting of oxygen to remove a portion of said etch residue, stopping said oxygen plasma contacting before said polymer etch residue is completely removed and thereafter removing any remaining said residue by contacting said opening with a second plasma, said second plasma consisting of a hydrogen containing gas, and treating said opening with at least one of ammonium chloride or phosphoric acid to remove a nitride deposit formed by said second plasma." This is not taught or suggested by Zhao et al. and Smith.

As explained above, neither Zhao et al. nor Smith teaches or suggest a two-plasma process of removing etch residue, i.e., "contacting said opening with a plasma consisting of oxygen to remove a portion of said etch residue, stopping said oxygen plasma contacting before said polymer etch residue is completely removed and thereafter removing any remaining said residue by contacting said opening with a second plasma." For this reason alone, the claims are patentable over these references. Additionally, neither reference teaches or suggests the controlling of a first plasma treatment, i.e., "stopping said oxygen plasma contacting before said polymer etch reissue is completely removed," as recited by the claim. Such control is simply not contemplated by the disclosures of Zhao et al. and Smith. Without teaching or suggesting this limitation, the combined references clearly fail to render the claim obvious.

Also, Zhao et al. does not teach or suggest use of ammonium chloride or phosphoric acid to remove nitride deposits after plasma removal of etch residue. Smith cannot supplement the Zhao et al. disclosure to suggest or provide this teaching as it, too, is silent on use of ammonium chloride or phosphoric acid for this purpose. For this reason as well, claim 16 is patentable over Zhao et al. in view of Smith. Applicants respectfully request that the 35 U.S.C. § 103(a) rejection of independent claim 16 and dependent claims 17, 18, 20-28, and 86-88 be withdrawn.

Claim 29 defines a method of forming a contact opening in a semiconductor device and recites "a) etching a contact opening in an insulative layer in said device down to a polysilicon element of said device; b) contacting said opening with an oxygen plasma to remove a portion of said etch residue; c) removing any remaining etch residue from said etched opening by contacting said opening with a plasma consisting of a hydrogen containing gas in the absence of added oxygen; and d) treating said contact opening with one of ammonium chloride and phosphoric acid after step (c)." This method is not taught or suggested by Zhao et al. in view of Smith.

As discussed above in relation to the patentability of other claims (e.g., claims 1 and 16), Zhao et al. and Smith fail to teach or suggest a two plasma treatment in a single residue removal process, i.e., "b) contacting said opening with an oxygen plasma to remove a portion of said etch residue; c) removing any remaining etch residue from said etched opening by contacting said opening with a plasma consisting of a hydrogen containing gas in the absence of added oxygen" as recited by the claim. For this reason alone, independent claim 29 is patentable over these references.

Additionally, neither Zhao et al. nor Smith teaches or suggests "d) treating said contact opening with one of ammonium chloride and phosphoric acid after step

(c)," as recited in the claim. For this reason as well, independent claim 29 is patentable over the references.

Since independent claim 29 is patentable over Zhao et al. and Smith, so are dependent claims 30, 31, 34-39, 41-44, and 89-91. Applicants respectfully request that the 35 U.S.C. § 103(a) rejection of these claims be withdrawn.

Claim 54, as defined above in relation to the rejection of the claim over Zhao et al. and Chen, is likewise patentable over Zhao et al. in view of Smith. Smith, like Chen, fails to remedy the deficiencies of the Zhao et al. reference. Neither Zhao et al. nor Smith teaches or suggests "first contacting said opening with a first plasma to remove a portion of said polymer etch residue" and "stopping said first contacting" and "subsequently contacting said opening with a second plasma to remove the remainder of said polymer etch residue," for the same reasons discussed above in relation to the patentability of claims 1, 16, and 29. Clearly, Zhao et al. fails in this regard, and in fact, teaches away from these limitations. Smith too fails since it does not teach a two plasma technique for removing residue in a single process. For the same reasoning as set forth above for the patentability of claims 1, 16, and 29 over Zhao et al. and Smith, independent claim 54 is patentable over Zhao et al. and Smith. Applicants respectfully request that the 35 U.S.C. § 103(a) rejection of claims 54-69 be withdrawn.

Claim 70 defines a method for removing polymer etch residue from an etched opening in a silicon wafer device and recites, in part, "removing said polymer etch residue by contacting it with a first plasma and a second plasma, said first plasma being used to remove only a portion of said residue, said second plasma being used to remove the remainder of said polymer etch residue, said first plasma generated from a

gas not containing hydrogen and said second plasma generated from a gas consisting of methane gas, wherein said removal of said polymer etch residue produces no silicon rich oxide in said opening." Such a method is not taught or suggested by Zhao et al. and Smith.

Zhao et al. and Smith fail to teach or suggest, expressly or inherently, use of a two plasma technique for removing etch residue in a single process, as discussed at length above in relation to other claims. Further, neither Zhao et al. nor Smith teaches or suggests that removal of the polymer etch residue by the method produces no silicon rich oxide in the opening. Therefore, for at least these reasons and for the same reasoning as set forth above for the patentability of claims 1, 16, and 29 over Zhao et al. and Smith, independent claim 70 and dependent claims 71-82, 84, and 85 are patentable over these references. Applicants respectfully request that the 35 U.S.C. § 103(a) rejection of these claims be withdrawn.

Claims 50, 52, 53, 92-95, and 97 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Zhao et al. in view of Smith, further in view of U.S. Patent 6,284,664 ("Kawai"), and further in view of U.S. Patent 6,291,890 ("Hamada"). Applicant respectfully traverses this rejection.

Claim 50 defines a method of forming an integrated circuit structure and recites, in part, "removing polymer residue from said contact opening by first contacting said opening with a first plasma, stopping said first contacting, and subsequently contacting said opening with a second plasma, said first plasma consisting of a gas other than ammonia gas and said second plasma consisting of ammonia gas, said first and second plasma treatments being configured to prevent the

formation of silicon oxide on a bottom of said contact opening; treating said bottom of said contact opening to remove any nitride formed by said second plasma." Such a method is not taught or suggested by Zhao et al. in view of Smith and in view of Kawai and in view of Hamada.

None of Zhao et al., Smith, Kawai, and Hamada teaches or suggests a two plasma technique for removal of etch residue in a single process where no silicon rich oxide is formed during said removal. Such limitations have been discussed at length above in relation to rejections over Zhao et al. and Smith and the arguments will not be restated here. Kawai and Hamada cannot supplement Zhao et al. and Smith so as to provide the missing instruction to use two plasmas in a residue removal method, the teaching or suggestion of such a technique is simply lacking in all four references. Further, none of the cited references teaches or suggests "said first and second plasma treatments being configured to prevent the formation of silicon oxide on a bottom of said contact opening; treating said bottom of said contact opening to remove any nitride formed by said second plasma." For these reasons, independent claim 50 and dependent claims 52 and 53 are patentable over the refernces. Applicants respectfully request that the 35 U.S.C. § 103(a) rejection of independent claim 50 and dependent claims 52 and 53 be withdrawn.

Claim 92, as amended, defines a method of forming an integrated circuit structure and recites, in part, "removing polymer residue from said contact opening by first contacting said opening with a first plasma, stopping said first contacting, and second contacting said opening with a second plasma, said first plasma comprising a gas not containing hydrogen and said second plasma consisting of hydrogen gas and said first and second plasmas being configured to not leave silicon oxide in said opening after said first and second contacting, wherein said second contacting provides

an oxide free bottom of said contact opening and does not oxidize sidewalls or said bottom of said opening." Such a method is not taught or suggested by Zhao et al. combined with Smith combined with Kawai and combine with Hamada.

Among other recited features in this claim, none of the cited references teaches or suggests first and second plasma treatments for removing etch residue in a single process. Additionally, none of the references teaches or suggests that a two plasma technique can be "configured to not leave silicon oxide in said opening after said first and second contacting." Additionally, none of the cited references teaches or suggests that the removal of polymer etch residue using two plasma treatments "provides an oxide free bottom of said contact opening and does not oxidize sidewalls or said bottom of said opening." For each of these reasons, Applicants respectfully request that the 35 U.S.C. § 103(a) rejection of claims 92-94 be withdrawn.

Claim 95, as amended, defines a method of forming an integrated circuit structure and recites, in part, "removing polymer residue from said contact opening by first contacting said opening with an oxygen plasma, stopping said first contacting, and second contacting said opening with a methane-comprising plasma, said removing preventing the formation of silicon rich oxide at the bottom of said contact opening." Such a method is not taught or suggested by the combination of Zhao et al., Smith, Kawai, and Hamada.

As has been discussed above in relation to other claims, none of the cited references teaches or suggests a dual plasma technique to remove polymer etch residue in a single process, much less one that includes "preventing the formation of silicon rich oxide at the bottom of said contact opening." For at least this reasoning, Applicants

respectfully request that the 35 U.S.C. § 103(a) rejection of claims 95 and 97 be withdrawn.

In view of the above amendment, Applicants believe the pending application is in condition for allowance. Applicants respectfully request that a Notice of Allowance be immediately mailed.

Dated: October 6, 2005

Respectfully submitted,

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